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THE FIVE-FACTOR PERSONALITY MODEL AND NAVAL AVIATION CANDIDATES

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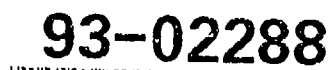

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SUMMARY PAGE

OVERVIEW

As personality testing has improved, various models for constructing and interpreting aviation selection tests have been proposed. Of particular interest to our study is the use of the five-factor personality model to naval aviation selection test interpretation and development. The five personality factors are conscientiousness, agreeableness, openness, extraversion, and neuroticism. Therefore, we conducted a joint factor analysis on the Pilot Personality Questionnaire (PPQ) and the Edwards Personal Preference Schedule (EPPS) taken by 158 Navy and Marine Corps student aviators. A principal component analysis (PCA) and a factor analysis (FA) with varimax rotations produced a robust five-factor solution. On the basis of content analysis, the FA factors obtained in our study coincided with the five classic dimensions of the five-factor personality model. Although investigations of personality in pilot selection have yielded mixed results, the finding of a five-factor solution in our study suggests that the five-factor personality model may be useful in personality testing in aviation selection decisions.

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INTRODUCTION

Military pilot selection decisions have typically relied on cognitive and psychomotor skills (Hilton & Dolgin, 1991). Recent studies, however, have demonstrated that certain personality traits may be important in the ultimate training success of naval pilot candidates (e.g., Street, Helton, & Dolgin, 1992). The increasing importance of personality tests to personnel selection, particularly military pilot selection, establishes the significance of applying improved personality testing constructs to further enhance selection decisions. A principal aim of personality research has been to describe human behavior in terms of a number of fundamental traits or factors. Until recently, however, researchers have been unable to agree on a general personality model or the number of factors needed to adequately describe most aspects of human behavior (Digman, 1990). The five-factor personality model has been increasingly cited as a solution to this dilemma. Pedersen, Allan, Laue, and Siem (1992) reviewed a number of personality theories and concluded that the five-factor personality model had the greatest potential in Air Force aircrew selection and classification research.

The advent of factor analytic techniques in the late 1940s, made statistical solutions to the question of an adequate personality model possible. Fiske (1949) applied such techniques to a variety of personality ratings and identified a five-factor solution. His results were based on principal component procedures and were later replicated in analyses by Tupes and Christal, in 1961 (cited in Digman, 1990), and Norman (1963). Norman (1963) labeled the factors 1) extroversion or surgency, 2) agreeableness, 3) conscientiousness, 4) emotional stability, and 5) culture.

These findings were generally overlooked until Goldberg, in 1981, identified five similar factors by forming a set of synonyms from the dictionary (cited in Digman, 1990; McCrae & Costa, 1990). Research generally supports the application of the five-factor model to the interpretation of personality testing (Barrick & Mount, 1991; McCrae & Costa, 1986, 1989a; Noller, Law & Comrey, 1987). The individual factors are comprised of a variety of distinct traits and behavior patterns (McCrae & Costa, 1989b). The model describes an individual's emotional, interpersonal, experiential and motivational styles (Costa, Busch, Zonderman, & McCrae, 1986; Costa & McCrae, 1988; McCrae & Costa, 1989b). For the purpose of this report, the five factors will be referred to by McCrae and Costa's (1985) designations: extraversion, neuroticism, openness, agreeableness, and conscientiousness.

The first factor, extraversion, includes such behaviors as sociability, a fun-loving disposition, tenderness, warmth, gregariousness, assertiveness, friendliness, activity, need for affiliation, exhibition and dominance. Other behaviors commonly classified in this area are a disposition toward positive emotions versus aloofness, emotional blandness, reservation, and seriousness (Barrick & Mount, 1991; Conn & Ramanaiah, 1990; Gerbing & Tuley, 1991; Marshall, Wortman, Vickers, Kususlas, & Hervig, 1991; McCrae & Costa, 1986, 1987, 1989a; McCrae, Costa & Busch, 1986).

Neuroticism refers to Norman's (1963) emotional stability dimension. This factor is described by negative affect traits or behaviors (McCrae & Costa, 1987). Traits describing individuals characterized by neuroticism are anxiety, hostility, depression, self-consciousness, vulnerability, insecurity, concern, guilt, sensitivity, irritability, anger, and the need for succorance and nurturance (Barrick & Mount, 1991; Conn & Ramanaiah, 1990; Gerbing & Tuley, 1991; McCrae & Costa, 1986, 1987, 1989a; McCrae, et al., 1986). Individuals who score low on measures of neuroticism are characterized as rational, calm, consistent, secure and self-satisfied (McCrae & Costa, 1986; McCrae, et al., 1986).

Agreeableness has also been called likability or friendly compliance vs. hostile noncompliance (Barrick & Mount, 1991; Digman & Takemoto-Chock, 1981). Individuals who are classified as agreeable are characterized by traits such as warmth, sympathy, altruism, cooperation, courtesy, flexibility, tolerance, caring, nurturance, and having an inclination toward interpersonal trust and consideration of others (Barrick &

Mount, 1991; Conn & Ramanaiah, 1990; Digman, 1990; Marshall et al., 1991; McCrae & Costa, 1986, 1989a). Opposite characteristics include mistrust, skepticism, callousness, uncooperativeness, stubbornness, rudeness, condescension, antagonism, hostility, jealousy, aggression and indifference (Conn & Ramanaiah, 1990; Digman, 1990; McCrae & Costa, 1986, 1987; McCrae, et al., 1986).

Conscientiousness is described as behaving in a manner that is thorough, careful, governed by conscience, dutiful, moralistic, scrupulous, hardworking, ambitious, energetic, persevering, responsible, organized, achievement-oriented, self-disciplined, and industrious (Barrick & Mount, 1991; Marshall et al., 1991; McCrae & Costa, 1986, 1987, 1989a; McCrae, et al., 1986). Individuals scoring low on measures of conscientiousness would be characterized as being disorganized, careless, weak-willed, and impulsive (McCrae & Costa, 1986; McCrae, et al., 1986).

Openness, the final dimension, has been the most difficult dimension to describe (Barrick & Mount, 1991). Individuals scoring high on this factor are considered original, imaginative, curious, daring, and cultured. In addition, they have broad interests and aesthetic sensitivity, enjoy fantasy, and have a receptive orientation toward varied experiences. Low scores on this dimension are associated with a down-to-earth, conforming, and resistant-to-change nature. Openness has been referred to as openness to experience, creativity, intellect, and general intelligence (Barrick & Mount, 1991; Digman, 1990; Digman & Takemoto-Chock, 1981; Goldberg, 1990; McCrae & Costa, 1985b, 1989a).

Interest in the five-factor model led McCrae and Costa (1985) to develop the Neuroticism-Extraversion-Openness Personality Inventory (NEO-PI) and the NEO-PI rating form, two inventories designed to assess the five dimensions. The NEO-PI is a self-report inventory, while the NEO-PI rating form is designed for peer ratings. McCrae and Costa (1985) suggest that the five-factor model can be found in many different test formats. For example, they administered the Adjective Check List (ACL), the NEO-PI, and the NEO-PI rating form to 292 males and 206 females. The resulting varimax-rotated principal components roughly corresponded to Norman's (1963) "big five."

Subsequent investigations of various other personality inventories have been consistent with the work of McCrae and Costa (1985). Across a variety of samples, studies with the California Q-Set (McCrae, et al., 1986), Jackson's Personality Research Form-E (Costa & McCrae (1988), the Myers-Briggs Type Indicator (McCrae & Costa, 1989a) and the Comrey Personality Scales (Conn & Ramanaiah, 1990) have identified five-factor solutions comparable to those of Norman (1963). The primary method of analysis has been through application of principal component techniques with orthogonal, varimax rotation to obtain simple factor structure. Critics of the model have argued that five-factor solutions were often the statistical artifact of the factor extraction and rotation methods used (Goldberg, 1990).

Goldberg (1990) attempted to address this issue by using a variety of factor extraction procedures to analyze the personality test results. These include, principal-components, principal-factors, alpha-factoring, image-factoring, and maximum-likelihood procedures. The factors extracted in the various procedures were rotated using orthogonal and oblique algorithms. The findings did not change as a function of the method used. Goldberg (1990) concluded that the five-factor solution was statistically robust.

Although there is a great deal of empirical support for the presence of a five-factor model, not all researchers have found a five-factor solution. For example, Noller, Law and Comrey (1987) conducted a joint factor analysis of the 16PF, the Comrey Personality Scales and the Eysenck Personality Inventory. Both a varimax rotation and an oblique rotation led to a seven factor solution. They concluded that their results provide support for 4 of the 5 factors, but that 7-10 factors are probably necessary to account for all aspects of personality. A summary article by Digman and Takemoto-Chock (1981) cited numerous studies of various personality instruments and found historic factor solutions from four to eight factors, although solutions of six to eight factors appear to mirror the "big five."

We found only one study in the literature that directly applied the five-factor model to personnel selection. Barrick and Mount (1991) investigated the usefulness of the five personality dimensions in samples of professionals, police, managers, sales people, and skilled/semiskilled workers. They used job proficiency, training proficiency, and personnel data to measure job performance. They found that conscientiousness consistently predicted job performance for each group across job performance measures.

Only three studies found in the literature investigated military samples, and only one looked at military aviation samples. The first, a study cited by Digman and Takemoto-Chock (1981) of 790 U.S. Air Force officer candidates, produced a five-factor solution. The second (Marshall et al., 1991), investigated the relationship between personality factors and health in two Navy recruit samples (N = 292, N = 451). They used 24 indexes from a variety of personality measures, including the Neuroticism-Extraversion-Openness Personality Inventory (NEO-PI) and the NEO Five-Factor Inventory (NEO-FFI) and found that three superordinate dimensions accounted for the correlations observed. These dimensions corresponded to neuroticism, extraversion, and agreeableness, with limited evidence of the openness or conscientiousness dimensions.

The final study (Siem, 1990), investigated the underlying structure of the Automated Aircrew Personality Profiler (AAPP). The AAPP consists of items from scales including the Minnesota Multiphasic Personality Inventory, the State-Trait Anxiety Inventory, the Personal Orientation Inventory, the Jenkins Activity Survey, and others. The AAPP was applied to 509 candidates for USAF undergraduate pilot training. Siem (1990) applied principal factor techniques with oblique rotations to obtain a five-factor solution. The factors were similar to those expected, based on the five-factor model, although the five-factor model was not cited at that time.

Based on a review of the personality research available, Pedersen, et al. (1992) concluded that the five-factor personality model should be used as the theoretical framework for Air Force pilot selection personality research. They discussed several personality models and noted that the five-factor model was sufficiently robust for such application.

The purpose of the present investigation was to determine if a joint factor analysis of the Pilot Personality Questionnaire (PPQ) and the Edwards Personal Preference Schedule (EPPS) taken by U.S. Navy and Marine Corps aviators would produce a five-factor solution corresponding to the five-factor personality model. We believe that a robust five-factor solution might be useful in condensing various personality tests into a smaller set of variables that might account for a greater amount of variance than the individual tests. As noted by Pedersen et al. (1992), the five-factor solution might be useful in an improved pilot selection system.

METHODS

SUBJECTS

The subjects participating in this study were 158 U.S. Navy and Marine Corps male aviator candidates ranging in age from 22 to 28 years (M = 24.19, SD = 1.64). All subjects took the EPPS and the PPQ at the Naval Aerospace Medical Research Laboratory between January of 1990 and February of 1991 as part of an ongoing selection research project. Their participation in the project was strictly voluntary. Before taking the tests, all subjects were informed that their decision to participate and their test results would not affect their status in the flight program and would not be entered into their service record.

APPARATUS

The PPQ was administered on a Zenith 248 microcomputer with a Zenith monochrome monitor. Response entry was via a numeric keypad. The EPPS was administered in paper-and-pencil format and scored manually.

MATERIALS

The PPQ is a self-administered, untimed, personality inventory containing 112 multiple-choice items. The test is a combination of four different personality tests: 1) Locus of Control (LOC), 2) Work and Family Orientation (WOFO), 3) Personality Attributes Questionnaire (PAQ), and 4) the Social Desirability Scale (SDS). These four tests were included because of their previous use as pilot personality measures.

The LOC (Rotter, 1966) was designed to measure an individual's attribution or cause and control of life events. The scale separates causal attribution as being either self-controlled (internal) or controlled by others (external). The WOFO (Helmreich & Spence, 1978) is a measure of achievement motivation and attitudes toward family and career. The PAQ (Spence, Helmreich, & Holahan, 1979) measures socially undesirable behaviors such as hostility and aggressiveness. The SDS (Crowne & Marlowe, 1960) was included as a measure of motivation and as a way of reducing response bias by measuring self-report distortion.

Subjects' responses were partitioned into 12 scales designed to measure assertiveness, interpersonal orientation, aggressiveness, hostility, verbal aggressiveness, submissiveness, high-mastery motivation, high-work motivation, competitiveness, self-control, fatalism, and social desirability. (See Dolgin & Gibb (1989) for a discussion).

The EPPS is a paper-and-pencil personality test that was developed for counseling and research purposes and provides measures of 15 "normal" personality traits (Edwards, 1959). This inventory uses a forced-choice format in which two statements with equal social desirability value are paired together, and the subject must select the statement that best describes him or her. The 15 traits are achievement, deference, order, exhibition, autonomy, affiliation, intraception, succorance, dominance, abasement, nurturance, change, endurance, heterosexuality, and aggression.

DATA ANALYSIS

Our initial exploration took the form of a principal component analysis (PCA) of the 15 scales of the PPQ and the 12 scales of the EPPS for the entire sample. Eigenvalues were analyzed using Kaiser's (1960) procedures and Cattell scree tests (1966) to confirm the number of components for rotation. We then conducted a principal factor analysis (PFA) in order to arrive at a solution where unique variance and error variance are minimized. The resulting PFA solution is preferred for structural interpretation (Tabachnick & Fidell, 1983). The loading matrix produced by an orthogonal (varimax) rotation of the correlation matrix was used as the basis of factor interpretation. Orthogonal rotation produces factors that are considered less ambiguous than other procedures. The resulting subject-to-variable (factor) ratio exceeded the 20:1 ratio recommended by Arrindell and Van der Ende (1985) for factor stability. We compared the loadings' matrix of correlations between the subtests of the EPPS and PPQ and the components with the five-factor model of personality. We assigned labels to the principal factors obtained based on a review of the general content of the subtests with an absolute correlation value greater than .30. The resulting expert comparison was the basis of the exploratory recommendations.

Principal component analysis produces *components* that account for all the variance in each variable. This includes the variance shared with other variables in the set and that variance specific to the variable itself. The l[illegible]rocedure is primarily exploratory and is typically used to determine the number of

components. The PFA procedure used by Siem (1990) produces *factors*. Only the variance shared with other variables in the analysis is considered in the PFA solution. The PFA technique is typically used to produce interpretable solutions. Once factors or components have been extracted, the matrices must be rotated to arrive at a simple structure for interpretation. There are a number of rotational techniques available. The two primary methods are orthogonal and oblique. In an orthogonal rotation, the components are uncorrelated with each other. The oblique rotation produces factors that are correlated with each other.

RESULTS

Means and standard deviations of the raw scores for the 15 scales of the EPPS and the 12 scales of the PPQ are presented in Table 1. The scale scores were normally distributed.

Table 1. Means and Standard Deviations (*SD*) for the EPPS and PPQ (N = 158).

Variable	Mean	*SD*
Edwards Personal Preference Schedule		
Achievement	16.75	3.89
Deference	11.38	3.24
Order	9.77	4.51
Exhibition	14.53	3.89
Autonomy	12.92	4.35
Affiliation	13.72	4.07
Intraception	14.48	4.12
Succorance	7.91	3.78
Dominance	18.80	3.70
Abasement	11.81	4.57
Nurturance	12.95	4.76
Change	17.44	4.47
Endurance	15.04	4.84
Heterosexuality	17.66	5.08
Aggression	14.57	4.82
Pilot Personality Questionnaire		
Assertiveness	26.98	2.93
Interpersonal orientation	20.99	3.87
Aggressiveness	20.82	3.72
Hostility	14.32	4.76
Verbal aggressiveness	3.89	2.48
Submissiveness	5.18	1.93
Mastery motivation	22.84	3.89
Work motivation	22.53	1.85
Competitiveness	15.09	2.98
Self-control	22.07	4.54
Fatalism	15.16	6.83
Social desirability	76.69	14.80

Our initial examination of eigenvalues for the components extracted through PCA revealed five factors with values over 1.0. The scree separation was strongest after the first two components, although five factors were retained on the basis of eigenvalues over 1.0 (Kaiser, 1960). The PFA also resulted in five factors with eigenvalues over 1.0. The concurrence in the two extraction procedures suggests a fairly robust five-factor structure for the subtests of the EPPS and PPQ. The normalized orthogonal rotation of the PFA correlation matrices yielded a five-factor solution, which accounted for 28% of the variance in the EPPS and PPQ subtests.

The correlations of the various EPPS and PPQ scales with the five PFA factors are shown in Table 2. The first factor (FAC1) accounted for about 14% of the total variance and was defined by scales that reflected behaviors commonly found in the friendly compliance versus hostile noncompliance dimension. This factor is labeled agreeableness in the five-factor personality model. The second factor (FAC2) accounted for about 8% of the variance and included scales focusing on the will to achieve found in the five-factor model conscientiousness dimension. The third factor (FAC3) accounted for about 2% of the variance and was defined by scales reflecting the openness dimension. The fourth factor (FAC4) was similar to the neuroticism dimension and accounted for roughly 2% of the remaining variance, while the fifth factor (FAC5) resembled the extraversion dimension and accounted for about 1% of the variance remaining.

Table 2. Varimax Rotated Principal Factor Analysis.[1]

Scale	Factor FAC1	FAC2	FAC3	FAC4	FAC5
Edwards Personal Preference Schedule					
Achievement		51			
Deference	-49		-31		35
Order			-81		
Exhibition		43			
Autonomy		58	37		
Affiliation	-31	-47	47		
Intraception					50
Succorance				53	
Dominance				-65	
Abasement	36				52
Nurturance		-72			
Change			35		
Endurance			-65	-34	
Heterosexuality				49	-49
Aggression	68	34			
Pilot Personality Questionnaire					
Assertiveness				-40	
Interpersonal orientation		-51			
Aggressiveness		30		-53	
Hostility	54	41			
Verbal aggressiveness	51				
Submissiveness				38	
Mastery motivation				-59	
Work motivation				-36	
Competitiveness					
Self-control	-31				
Fatalism				33	
Social desirability	-41			-43	
Eigenvalues	3.70	2.81	1.58	1.45	1.19
% of Variance Explained	13.73	7.89	2.51	2.10	1.41

[1]Decimals omitted.

The five factor solution we obtained was conducted on 27 scales that were made up from a total of 337 questions. Summaries of the descriptors that comprise the five factors are shown in Figure 1.

1. AGREEABLENESS	2. CONSCIENTIOUSNESS	3. OPENNESS
Not follow instructions	Outdo others	Not get suggestions
Not get suggestions	Be witty and clever	Not organized
Not be loyal	Be autonomous	Can handle change
Not participate in groups	Not be loyal	Be able to come and go as desired
Accept blame for wrongdoing	Not help others	Be loyal
Criticize publicly	Not able to devote self	Do new and different things
Greedy	Not submissive	Not resolute
Self-centered	Boastful	
Whiny and naggy	Criticize publicly	
Impulsive		
Not socially oriented		

4. NEUROTICISM	5. EXTRAVERSION
Need support	Gets suggestions from others
Need encouragement	Follows instructions
Do not persuade others	Analyzes people's motives
Not resolute	Observes others
Sexually oriented	Accepts blame and punishment for wrongdoings
Passive	Not sexually oriented
Feels inferior	Subordinate self to others
Need for security	Negative work attitudes
Dislikes challenging tasks	
Believes fate controls lives	
Not socially oriented	

Figure 1. Descriptors of the five factors.

Following the principal factor analysis, we derived five factor scores for each subject. The factor scores were a linear composite of the products of the subtest raw scores and their respective factor loadings. We treated negative loadings as negative values in the linear composite calculation for each factor. The resulting factor composite scores were then analyzed to determine factor intercorrelations (Table 3). As shown in Table 3, FAC1 (agreeableness) was positively correlated to FAC2 (conscientiousness), FAC3 (openness), and FAC4 (neuroticism). The neuroticism (FAC4) dimension was positively correlated with FAC3 (openness), while extraversion (FAC5) was negatively correlated with FAC2 (conscientiousness) and FAC4 (neuroticism). These relationships indicate that agreeable or compliant responses are associated with conscientious, flexible (open), and emotionally stable (neuroticism dimension) responses. Similarly, flexibility and openness to change are also associated with emotional stability (neuroticism). In contrast, more extraverted (FAC5) responses were less likely to be associated with conscientious (achievement oriented) and neuroticism (emotional maturity).

Table 3. Intercorrelations of the Five Principal Factors (N = 158).

Factor	FAC1	FAC2	FAC3	FAC4	FAC5
1. Agreeableness	--				
2. Conscientiousness	.49**	--			
3. Openness	.19*	-.04	--		
4. Neuroticism	.54**	-.09	.43**	--	
5. Extraversion	-.13	-.19*	-.11	-.19*	--

* $p < .05$
** $p < .01$

DISCUSSION

Our investigation of the EPPS and PPQ suggests that a robust five-factor solution may describe the underlying personality testing constructs in Navy/Marine Corps student aviators. This five-factor solution is essentially the same as that proposed by Fiske (1949), Norman (1963), and Pedersen et al. (1992).

Our findings provide additional support for the existence and robustness of the five factor model across personality instruments and samples. The study represents the first application of the model to student Navy/Marine Corps aviators. Previous studies have addressed the relationship between the five factors and job success across different job classifications (Barrick & Mount, 1991). Their results provided compelling support for the predictive utility of the conscientiousness factor. Pedersen et al. (1992) suggest that this model provides a descriptive framework of the fundamental domains of personality and serves as a scientific organization for the generation of personality-based predictors for selection and classification. Because our research was strictly exploratory and we do not presently have sufficient criterion data, we are unable to draw firm conclusions about its effectiveness in enhancing naval aviation selection. Nonetheless, the results do provide direction for future research in personality test development and measurement.

The focus of personality research in naval aviation should be centered on prediction systems that are based on the grouping of various personality scale subtests into a five-factor model. A method based on this arrangement may explain more variance than the individual scales. Previous attempts to identify and validate personality traits as predictors of aviation training success have been unsuccessful (Davis, 1989; Hilton & Dolgin, 1991). It is possible that these efforts were unsuccessful because researchers were addressing only a portion of a more comprehensive description of personality. For example, Street et al. (1992) did find that competitiveness significantly distinguished attrites from successful trainee candidates. Additional selection research using the five-factor model is needed to determine if its five domains are more valuable than their corresponding lower-order scales or traits. The five-factor model of personality identified in this research ay prove to be a useful tool for the selection of Navy/Marine Corps aviators.

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As personality testing has improved, various models for constructing and interpreting aviation selection tests have been proposed. Of particular interest to our study is the use of the five-factor personality model to naval aviation selection test interpretation and development. The five personality factors are conscientiousness, agreeableness, openness, extraversion, and neuroticism. Therefore, we conducted a joint factor analysis on the Pilot Personality Questionnaire (PPQ) and the Edwards Personal Preference Schedule (EPPS) taken by 158 Navy and Marine Corps student aviators. A principal component analysis (PCA) and a factor analysis (FA) with varimax rotations produced a robust five-factor solution. On the basis of content analysis, the FA factors obtained in our study coincided with the five classic dimensions of the five-factor personality model. Although investigations of personality in pilot selection have yielded mixed results, the finding of a five-factor solution in our study suggests that the five-factor personality model may be useful in personality testing in aviation selection decisions.

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